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Marsh Dam,
Plentywood,
Montana, Sheridan
County, MT 1543

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MEMORANDUM FOR THE RECORD
NATIONAL DAM SAFETY PROGRAM

MARSH DAM
PLENTYWOOD, MONTANA
SHERIDAN COUNTY
MT 1543

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PREPARED FOR:

HONORABLE TED SCHWINDEN
GOVERNOR, STATE OF MONTANA

DAVE MARSH AND GORDON THOMPSON
CO OWNERS/CO-OPERATORS

PREPARED BY:

HKM ASSOCIATES
BILLINGS, MONTANA

FEBRUARY 1981

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Plentywood,
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County, MT 1543

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PLENTYWOOD, MONTANA
SHERIDAN COUNTY
MT 1543

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EXECUTIVE SUMMARY

Under contract with the Montana Department of Natural Resources and Conservation (DNRC), and with representation from the DNRC, the Soil Conservation Service (SCS), and the owners, HKM Associates inspected Marsh Dam on July 10, 1980. The inspection and evaluation were performed under the authority of Public Law 92-367. The dam is located on Marron Creek, a tributary to Box Elder Creek, in Sheridan County, Montana. More specifically, Marsh Dam is located in Section 6, T35N, R56E, and about 6 miles northeast of Plentywood, Montana.

This memorandum for the record was compiled from information obtained during the onsite inspection and review of available project design and construction information.

FINDINGS

Marsh Dam is co-owned and operated by Dave Marsh and Gordon Thompson. The dam and reservoir are located on private land. Principal use of the project is for a fish pond.

The 21-foot-high earth dam impounds about 63 acre-feet (AF) of water to the controlling low-point elevation for first overtopping of the dam embankment (elevation 104.0 feet, local datum). On the basis of criteria in the U.S. Army Corps of Engineers Recommended Guidelines for Safety Inspection of Dams (Ref. 1), the project is small in size.

At this time the project is classified as having a significant (Category 2) downstream hazard potential. Inspection criteria (Ref. 1) recommmend that a small-sized project with a significant downstream hazard potential be capable of safely handling a flood in the range of the 100-year recurrence interval to one-half the probable maximum flood (PMF). Based on downstream risk, our recommendation is that this project be able to safely handle the 100-year flood. The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region.

An estimate of a runoff event resulting from a 100-year, 6-hour rainfall was made to make a comparison between an estimated spillway design flood and the existing storage/outflow capability. The peak inflow to the reservoir resulting from a 100-year, 6-hour rainfall was calculated to be about 610 cubic feet per second (cfs), as compared to the maximum spillway discharge to the controlling elevation for first overtopping (104.0 feet, local datum) of 440 cfs. In terms of total runoff volume, the 100-year, 6-hour storm resulted in a total inflow

volume of about 125 AF. As stated above, maximum storage at Marsh Dam amounts to 63 AF, only 13 AF of which is above the spillway crest elevation (102.5 feet, local datum). The flood was not routed through the reservoir, but it is obvious from reviewing the above results that the storage/outflow capability of Marsh Dam is inadequate according to inspection criteria (Ref. 1).

The dam is constructed of materials that are relatively erodible and would fail in a short period of time when overtopped by floodwaters. A visual inspection of the embankment slopes indicated minor undulations and sloughing are occurring at various locations on the downstream slope. This activity appeared to be shallow and to include only the topsoil. Seepage was observed exiting from the downstream toe of the embankment. Seepage was also observed throughout the valley floor immediately downstream of the embankment, and a small spring was identified on the right (north) side of the downstream valley. Slight erosion gullies have developed on the downstream face due to spillage from ponding water on the dam crest. Some erosion due to wave action was evident on the upstream embankment face and reservoir shoreline. In general, there were no outward signs of major instability problems at Marsh Dam. No stability design information was available, but the phreatic surface through the embankment appears to be high. A proper evaluation of embankment stability according to the guidelines (Ref. 1) was not possible.

RECOMMENDATIONS

Because of the small size and significant downstream hazard potential of Marsh Dam, the complete Phase I inspection report required by the guidelines (Ref. 1) was not prepared. Instead, recommendations are provided based on a reduced scope of work and the above findings. The recommendations are as follows: develop and periodically test an emergency warning plan for use in the event of dam distress, and consider a plan for controlled evacuation of the pool during a distress condition; more fully evaluate the downstream hazard potential, refine the spillway design flood calculations, perform a downstream breach analysis, and improve the outflow capability commensurate with downstream risk; remove the slough willows from the spillway entrance; add rock riprap on the upstream face and along the shoreline where needed; place fill material between the cut spillway channel and the dam embankment to eliminate flow potential in this passageway during high pool levels; repair the dam crest; periodically inspect and repair embankment slopes where local sloughing has occurred; make an assessment of the phreatic surface through the dam, and perform and place on file a slope stability analysis of the embankment; conduct periodic inspections of the project; and monitor downstream development for changes in hazard potential associated with a breach of Marsh Dam.

Mike Keene

Michael D. Keene, P.E.

MONTANA
MICHAEL D. KEENE 4197 E
REGISTERED PROFESSIONAL ENGINEER

PERTINENT DATA SUMMARY

1. General

Federal ID Number	MT 1543
Co-owners and Co-operators	Dave Marsh and Gordon Thompson
Purpose	Fish Pond
Location	Section 6, T35N, R56E, MPM; 6 miles northeast of Plentywood, MT
County, State	Sheridan County, Montana
Watershed	Marron Creek, tributary to Box Elder Creek
Hazard Potential	Category 2 (Significant)
Size Classification	Small

2. Reservoir

Surface Area at Spillway Crest Elevation 102.5 feet, local datum	7 acres
Storage to Spillway Crest Elevation 102.5 feet, local datum	50 acre-feet
Total Storage to Controlling Elevation for First Overtopping (Elevation 104.0 feet, local datum)	63 acre-feet
Total Drainage Area	1.6 square miles
Reservoir Water Surface Elevation on the Day of the Inspection	98.5 feet, local datum

3. Spillway

Crest Elevation	102.5 feet, local datum

PERTINENT DATA SUMMARY
(Continued)

Type	Uncontrolled, trapezoidal shaped, open channel, with about a 60-foot level control section
Dimensions	100-foot base width, 1V on 5H side slopes, and variable bank heights with 2.5 feet maximum
Design Spillway Capacity	400 cubic feet per second
Spillway Capacity to First Overtopping	440 cubic feet per second

4. Outlet Works

None

5. Dam

Type	Zoned earth fill
Structural Height	27 feet
Hydraulic Height	21 feet
Design Crest Elevation	109.0 feet, local datum
Controlling Low-Point Elevation for First Overtopping	104.0 feet, local datum
Crest Length	400 feet
Dam Crest Width	13-14 feet
Upstream Dam Slope	1V on 3.5H (16 degrees measured)
	1V on 3.68H (as-built)
Downstream Dam Slope	1V on 2.6H (21 degrees measured)
	1V on 1.84H (as-built)

Note: The July 10, 1980 field survey used the spillway crest elevation (102.5 feet, local datum) as datum.

MEMORANDUM FOR THE RECORD

TO: The Record

FROM: Mike Keene, Hydrologist/Hydraulics Engineer, Team Leader
Dan Dyer, Geotechnical Engineer
Dan Nebel, Geologist

DATE: September 24, 1980

SUBJECT: Marsh Dam (MT 1543)
Field Inspection

PROJECT: 7M140.113, Contract No. WE-HKM-076

INSPECTION

Personnel of HKM Associates, with representation from the State of Montana Department of Natural Resources and Conservation (DNRC), the Soil Conservation Service (SCS), and the owners, inspected Marsh Dam (MT-1543) on July 10, 1980. The dam is located (Section 6, T35N, R56E, MPM) in Sheridan County, Montana about 6 miles northeast of Plentywood. The dam is owned and operated by Dave Marsh and Gordon Thompson as a fish pond.

According to criteria in the U.S. Army Corps of Engineers Recommended Guidelines for Safety Inspection of Dams (Ref. 1), the project is small in size. Prior to the inspection, there was some questions about the downstream hazard posed by this dam. After the dam inspection, a reconnaissance of the area downstream of the dam was made by Larry Tegg from the Montana DNRC, and the representatives from HKM Associates. It was found that failure of the dam would impact no more than one (1) inhabitable residence, a few private utilities, a few roads, and pasture farmland. Therefore, the project is classified as having a significant (Category 2) downstream hazard potential. Inspection criteria recommend that a small-sized project with a significant downstream hazard potential be capable of safely handling a flood in the range from the 100-year flood to one-half of the probable maximum flood (PMF). The PMF is the flood expected from the most severe combination of meteorologic and hydrologic conditions that are reasonably possible in the region. Because of the assessed downstream risk potential, it is recommended the project safely handle the 100-year flood. An estimate of a flood event resulting from the 100-year, 6-hour rainfall was made as a comparison to existing storage/outflow capabilities. The flood was not routed through the reservoir. However, it appears likely

that the embankment would be overtopped, or severely damaged along the left (south side), during flood events of this magnitude or greater.

The downstream hazard potential should be periodically reevaluated since future development near the creek may be affected by a breach of Marsh Dam.

Those present during the inspection included:

Mike Keene - HKM Associates Hydraulics Engineer and Team Leader
Dan Dyer - HKM Associates Geotechnical Engineer
Larry Tegg - Montana DNRC Dam Safety Engineer
Gus Abenroth - SCS Soil Conservation Technician
Merlin Berg - SCS District Conservationist
Dave Marsh - Co-owner
Gordon Thompson - Co-owner
Valentine Marsh - Local Resident
Melvin Christenson - Local Resident
Bill Wagner - Local Resident
Marlow Mehl - Local Resident
Joe Mehl - Local Resident

Because of the small size and significant downstream hazard potential of Marsh Dam, the complete Phase I inspection report was not prepared. Instead, information gathered from a review of available data and a field inspection is presented in this memorandum for the record.

DESCRIPTION OF THE PROJECT

Marsh Dam is located on Marron Creek, a tributary to Box Elder Creek, in Sheridan County, Montana. The closest population center is Plentywood, which is located about 6 miles downstream and to the southwest of the damsite (Appendix A and Ref. 2). The dam is classified as having a significant downstream hazard potential. Its Federal identification number is MT-1543. The 21-foot-high dam impounds approximately 50 acre-feet (AF) to the spillway crest (Ref. 3), and has an additional 13 AF of flood surcharge storage before reaching the controlling low-point elevation for first overtopping of the dam embankment (elevation 104.0 feet, local datum). The low-point on the embankment is 102.8 feet (local datum), but flows cannot reach this point without passing over a small bench area (refer to Exhibits C1 and C2 of Appendix C).

There is an uncontrolled, earth-lined spillway located at the left abutment (Photo 1 of Appendix B, and Exhibit C1 of Appendix

C). There is no outlet works facility, or any permanent means to evacuate the pool in the event of dam distress or for maintenance.

Principal use of the storage project is a fish pond.

REGIONAL GEOLOGY AND SEISMICITY

Marsh Dam is situated in the Northern Great Plains Province on Marron Creek in a subdued topography of broad undulating glacial plains. The surficial materials are heterogeneous glacial deposits ranging in size from clay to boulders. No faults, either recent or ancient, have been noted in the dam area. The strata beneath the glacial materials in the area consists of nearly flat-lying, soft shale. The bedrock is the Fort Union Formation (Tertiary).

Marsh Dam is in a relatively quiet seismic zone with the majority of the region's seismic events occurring in the southwestern Montana-Yellowstone Park area. Since 1925, Montana has experienced five shocks that reached intensity VIII or greater (Modified Mercalli Scale). The closest epicenter occurred at Helena, Montana which is approximately 425 miles west southwest of the damsite. No shocks of intensity IV or greater have been reported within a 100-mile radius of the site (as of January 1974). The dam is located in Zone 1 of the seismic zone map as shown in Reference 1. The seismic probability of Zone 1 is one of minor damage and is based on known distribution of damaging earthquakes and their associated intensities. In general, dams in seismic Zone 1 may be assumed to present no hazard from earthquakes provided static stability conditions are satisfactory and conventional safety margins exist (Ref. 1, 4).

SITE GEOLOGY

There is no geologic report of the damsite, however, the SCS drilled four exploration holes in the vicinity of the dam in October 1965. Location of the holes are not known. The dam is located in a small drainage with shallow valley walls. The valley section consists of approximately 13 to 28 feet of sand clay glacial till with heterogeneous pockets and seams of sand and gravel. Highly weathered shale underlies this glacial till.

DESIGN AND CONSTRUCTION HISTORY

Marsh Dam was designed by the Soil Conservation Service, Area Office, in 1966. Construction was performed in 1967. The construction contractor was Ron Dean Construction of Plentywood, Montana (Ref. 3).

Construction inspection was minimal, and no inspection diaries were kept. A SCS representative occasionally visited the site during construction. No quality control tests were performed during construction. There are no construction specifications, material testing results, or stability analysis. However, the appropriate Montana Standard Construction Specifications were used according to the SCS. It is reported by the co-owners and SCS Area Office personnel that no major problems were encountered during construction.

SPILLWAY

The spillway is located at the left abutment of the dam. The spillway is uncontrolled, broad-crested, earth-lined, and presently has a good vegetative cover (Photo 1 of Appendix B). Rock riprap has been placed at the inlet, particularly on the left side. There is presently a substantial amount of brush and small trees within the first 20 feet of the spillway channel. A barbed wire fence (three barbed-wire configuration) is located across the spillway channel about 50 feet downstream of the entrance (Exhibits C1 and C4). This fence is not expected to form much of an obstruction unless an unusual amount of debris or ice becomes a factor.

For approximately the first 60 feet downstream of the inlet, the spillway is trapezoidal in shape and is leveled at elevation 102.5 feet (local datum). Trapezoidal dimensions are as follows: base width is approximately 100 feet, bank heights are variable but a maximum of 2.5 feet high, and side slopes are about 5 horizontal to 1 vertical (Exhibit C4). The right bank of the spillway passes no closer than approximately 25 feet of the dam embankment. The spillway transitions from the trapezoidal section to natural terrain approximately 100 feet downstream of the inlet. Spillway flows then travel as overland flow until returning to Marron Creek approximately 150 feet downstream of the embankment toe. There is no energy dissipation facility at the return point to the valley.

The project owners say the spillway flows, on the average, every year. However, due to an extended dry period in this area, the reservoir pool has maintained a relatively low level for the past two years and the spillway has not operated. In terms of the historic highwater level, the owners claim the spring 1978 runoff resulted in the maximum pool level and a depth of about 12 inches was observed flowing through the spillway. Hence, the historic highwater level at Marsh Dam is identified as being elevation 103.5 feet (local datum). The 1978 event was primarily associated with snowmelt runoff, and due to the season and antecedent climatological conditions, some ice problems were

evident at the damsite. In particular, some ice deposits along the upstream face of the dam and at the spillway entrance created an obstruction to spillway flows. Farm machinery had to be mobilized to the site to break and move the ice to open a satisfactory passageway for the spillway flows.

Slough willows have historically flourished along the upstream face of the dam, at the spillway entrance, and in the spillway channel immediately downstream of the inlet (Photo 1). The owner attempts to keep the spillway entrance free from this type of obstruction by frequent mowing. Evidently, annual maintenance is required to control this type of willow. Maintenance has also been periodically performed along the reservoir shoreline and at the spillway entrance by placing rock riprap. The rock has been placed at isolated locations to provide bank protection against wave action. Even though there is a relatively dense cover of trees along the upstream face of the dam, this cover is not aligned to intercept the prevailing northwesterly winds. These winds are of sufficient magnitude to generate waves which can cause damage to erodible-type soils.

Complete spillway discharge rating data was not developed during design because of the scope of the project. The design files do indicate a maximum design discharge of 400 cubic feet per second (cfs) at a depth of 1.60 feet through the spillway control section (equivalent to an elevation of about 104.1 feet, local datum). This discharge approximately matches the SCS design runoff value for the upstream drainage basin of 394 cfs, which was based on a 25-year, 6-hour rainstorm (Ref. 3, 5). Snowmelt contributions were not considered in the design storm/runoff analysis even though it is recognized as the primary source of inflow to Marsh Dam. An estimate of a spillway design flood was made as a comparison to existing storage/outflow capabilities (see Hydrology). A detailed study of the spillway design flood and of the spillway discharge rating were not performed for Marsh Dam because of the scope of work.

FREEBOARD

The vertical distance between the low controlling first overtopping elevation and the reservoir level at the time of the inspection was 5.5 feet. The effective fetch (northwest by southeast) for wind-generated waves is less than 1000 feet and wave runup on the embankment is estimated to be equal to or less than 2 feet. The dam is expected to be overtopped, or severely damaged along the left (south) abutment contact, during the recommended spillway design flood (100-year flood event) and therefore no freeboard exists for such flood events. The vertical distance between the controlling first overtopping

elevation (104.0 feet, local datum) and the normal reservoir level (spillway crest elevation 102.5 feet, local datum) is inadequate to prevent overtopping the embankment by wind waves. Historically, maintenance has been required along the southeast shoreline and in the vicinity of the spillway entrance because of bank erosion associated with wind-generated waves. Rock riprap has been periodically placed in the problem areas and the localized erosion is now essentially controlled. On the upstream face of the dam, the slopes are mild and there is a dense cover of trees and brush which act to stabilize the slopes and minimize wave runup and erosion. However, some vertical cuts are evident here, as well.

HYDROLOGY

The drainage basin area for Marsh Dam is approximately 1.6 square miles, and consists of about 52 percent farmland (fallow and small grain) and 48 percent rangeland. The average grade of the main waterway through the upstream basin is 2 percent. Total length of the drainage area is estimated to be 11,220 feet (Ref. 3).

As can be observed in Photo 2 of Appendix B, the topography in the vicinity of the damsite generally consists of shallow to mild slopes and gently rolling terrain. The basin soils are generally described as well-drained loams and clay loams with moderate infiltration rates (Ref 6, 7). There is only a very small amount of forest cover in isolated locations of the basin. Because of the minimal forest cover, timber debris is not a problem at the reservoir.

The regional climate is classified as distinctly continental, with cold, dry winters and warm summers. Orographic effects on climate are relatively small. Regional variations in temperature and rainfall are not large, particularly when compared to the extreme variable pattern common to the more mountainous western sections of Montana. An important feature of the precipitation characteristics in the study area is that the majority of the annual precipitation falls during the growing season (see tabulation below, and Ref. 8).

In general, precipitation occurs as steady rains in the spring months of April through June, intermittent showers throughout the summer and early fall months, and as snowfall during the winter months. Snowfall is generally light in comparison to areas in western Montana (Ref. 6). However, because of the terrain, soil cover, soil characteristics, precipitation occurrence and amounts, etc., snowfall and snowmelt runoff play an important role in watershed yield for this basin. The nearest

climatological station having both precipitation and temperature records is at Westby, Montana, about 12 miles northeast of the Marsh Dam drainage basin. Mean annual precipitation at this station is 14.7 inches (41 years of record) and mean temperature is about 40 degrees F (37 years of record). The mean monthly precipitation for the Westby station from May through September is tabulated below for the recording period up through 1978 (Ref. 8):

Month	Precipitation, inches
May	1.91
June	3.21
July	2.03
August	2.07
September	1.16
Growing Season Total	10.38
Percent of Annual Total	71

Runoff is not measured upstream of the dam. There is a staff gage on Marron Creek near a county road approximately 1 mile downstream of the dam. The crest-stage gage is listed in the USGS Water Supply Papers as gage number 06183300 on Spring Creek. Evidently the study stream is referred to by either name. The peak discharge record period for this gage is 1955-1978 according to the 1978 Water Supply Paper. Peak discharge during the recording period was 32 cfs, which occurred in July 1978.

The original spillway design flood criteria for Marsh Dam was based on a 25-year, 6-hour rainfall (2.7 inches) and the SCS synthetic unit hydrograph technique. The estimated peak discharge resulting from the above criteria was 394 cfs, and the total runoff volume was about 66 AF (Ref. 3, 5). In comparison, the 100-year, 6-hour rainfall of 3.3 inches (Ref. 9) results in a peak runoff of about 610 cfs and a total runoff volume of 125 AF (see Appendix D for calculations). A hydraulic routing of the flood through Marsh Dam was not performed. However, it appears that the combination pool size and spillway capacity is inadequate to prevent an overtopping condition during floods of equal or greater magnitude than described above.

DAM EMBANKMENT

Limited construction drawings are available in the design file (Ref. 3). Some tracings of these construction drawings are included in Exhibits C3 and C4 of Appendix C. Marsh Dam was completed in 1967. The dam appears to be constructed of on-site sandy and silty clay. This material would be moderately erodible

if subjected to an overtopping condition and failure of the embankment would occur relatively rapidly.

The dam has a 13 to 14-foot crest width and is about 400 feet long (Photo 3 of Appendix B and Exhibit C2). The current structural height of the embankment is estimated to be 27 feet. The as-built construction drawings show the dam was built with slopes of 1V on 3.68H (vertical on horizontal) upstream and 1V on 1.84H downstream. Approximate field measurements of the embankment slopes with an Abney level (Exhibit C1 of Appendix C) were 16 and 21 degrees upstream and downstream, respectively. The upstream measurements, made above the water surface, approximately verify the construction drawings. The lower part of the slope was not measured as it was inundated at the time of this investigation. The measurement of the downstream slope is slightly flatter than shown in the plans. This is likely the result of inaccurate measurements, due to the vegetative cover and measuring instrument used, combined with an actual flattening of the slopes due to topsoil sloughing. There are two isolated areas on the upstream face of the embankment where riprap has been placed (Exhibit C1 of Appendix C) in recent years to check erosion (Photo 4). This riprap material is subrounded and well graded from 12 inches down to 2 inches in size. No bedding has been placed under the riprap. Some riprap has also been placed on the downstream slope, located opposite the riprap concentration shown in Photo 4, to check erosion.

There is a moderate to dense cover of natural grasses on the downstream face. Burrowing animals have also caused some damage on the downstream face (Photo 5). The upstream face has a heavy growth of willow trees in a narrow band near the normal pool elevation (spillway crest elevation 102.5 feet, local datum) (Photo 1).

A history of the dam construction, except for the as-built plans, is not available in the design file. An oral history of the construction was given during this investigation by SCS Field Office personnel who were present during construction. The history is as follows:

1. The embankment is a homogeneous section of clay.

2. The borrow source was the pool area.

3. A cutoff trench was constructed 2 to 4 feet wide and about 5 feet deep. This trench is backfilled with on-site clay (Exhibit C3).

4. The foundation was stripped of organic material prior to placement of the embankment.

5. The embankment was constructed in thin lifts, possibly 5 to 8 inches thick.

6. No particular effort was made for compaction. A roller was not used. Some compaction resulted from the normal operation of a rubber-tired grader as it spread the soil in lifts.

7. Compaction tests were not performed.

FOUNDATION CONDITIONS, SEEPAGE, AND DRAINAGE

The damsite is located in the glaciated region in northeastern Montana. Soils in the area are heterogeneous glacial tills consisting of clay, sand, and gravel.

Four drill logs were available for review in the design file (Ref. 3). The drilling was performed by the SCS. The drill logs indicate the subsurface profile consists of sandy and gravelly clay to depths of from 13 to 28 feet. The clay is embedded with thin sand and gravel seams. Shale was encountered at a depth of about 23 feet in the valley floor, 28 feet on the right (north) abutment, and at 13 feet on the left (south) abutment. There are no laboratory test results on file.

During the July 10, 1980 inspection, with the reservoir pool at approximately elevation 98.5 feet (local datum), seepage was observed exiting from the downstream toe of the embankment. The toe was saturated to a vertical height of about 5 feet. In addition, seepage was observed throughout the valley floor immediately downstream of the embankment (Photo 6 of Appendix B). A small spring area was also identified on the right (north) side of the downstream valley. Surface water flows from the seepage and spring were estimated, approximately 100 yards downstream, to be about 7 gallons per minute.

Runoff water from ponding on the dam crest which is the result of traffic damage (Photo 3) has resulted in concentrated flows and slight erosion gullies. This erosion does not presently create a safety hazard but should be monitored if the appropriate remedial work is not completed on the dam crest (see Recommendations).

STABILITY

Visual inspection of the embankment slopes indicate that minor sloughing is occurring at various locations on the downstream

slope (Photo 7 of Appendix B). Several undulations are evident at locations identified on Exhibit C3 of Appendix C. A small scarp about 6 inches high was distinctly identified near the toe of the slope (Photo 7). This sloughing appears to be shallow and includes only the topsoil.

There is no stability analysis information in the design file (Ref. 3). No major stability problems are evident; however, the location of the phreatic surface is unknown. The seepage identified on the downstream slope suggests the phreatic surface is high in the embankment and stability is questionable. However, sufficient information is not available for proper evaluation of stablility.

Some erosion due to wave action is evident on the embankment face and reservoir shoreline. There is a vertical cut up to 3 feet high on the reservoir shoreline near the mouth of the spillway. This low cut does not create a dam safety hazard. Erosion on the embankment is retarded by the riprap placed on the most vulnerable portion of the slope (Photo 4), and by the line of willows (Photo 3). However, the riprap protection is inadequate in most areas.

OPERATION AND MAINTENANCE

There is no formal operation and maintenance program. The project is essentially self-operating in the absence of a low-level outlet and because of the uncontrolled spillway. Inflows are not measured and pool levels are not monitored. Maintenance is performed only as needed; in fact, very little maintenance has been required since project completion. The owners have occasionally placed rock riprap in deficient areas and in areas critically exposed to wave erosion, which is generally along the southeast shoreline. Also, they occasionally cut the slough willows from the spillway entrance.

There is no formal inspection program. The owners and relatives farm the area in the vicinity of the damsite. In addition, friends and relatives use the fish pond. Hence, the owners feel that most signs of potential dam distress would be observed on an incidental basis rather than a visit to the site for the specific purpose of inspection and evaluation.

There is no formal warning system or plan of action in the event of dam distress.

SIZE AND DOWNSTREAM HAZARD POTENTIAL

The hydraulic height of Marsh Dam is 21 feet and the maximum storage is estimated to be 63 AF. The dam is classified as small in size. A reconnaissance of the area downstream of the dam revealed that only one (1) inhabitable residence would probably be impacted by a dam breach. Other miscellaneous damage potential includes some utilities, some private roads, a few county roads, a state highway, but primarily farmland and rangeland. Based on the above information, it is recommended that the dam be classified as a significant hazard structure. However, it should be periodically reevaluated since future development near Marron Creek may be affected by a breach of Marsh Dam.

RECOMMENDATIONS

1. Develop and periodically test an emergency warning plan for use in the event of dam distress. Also, develop a plan for controlled evacuation of the pool during a distress situation.

2. More fully evaluate the downstream hazard potential and include snowmelt contributions when defining the required spillway design flood. Improve the outflow capability as studies indicate.

3. Remove the slough willows from the spillway entrance and spillway channel on a regular basis.

4. Add properly designed rock riprap on the upstream face for erosion protection. Regular inspections are required of the southeast shoreline and at the entrance to the spillway due to potential wave attack and bank erosion. Place rock riprap as necessary.

5. Place a satisfactory fill material between the cut spillway channel and the dam embankment. This fill will eliminate the opportunity for flows to pass near the earthen embankment, which potentially could damage the left abutment contact area and pluck the erodible-type soils from the embankment.

6. Remove trees and brush from the dam embankment.

7. Eliminate rodents from the dam and abutments, and using suitable fill, properly repair and compact the damaged areas.

8. Using a suitable material, fill and properly compact all depressions and ruts along the dam crest.

9. Periodically inspect embankment slopes for sloughing. Repair areas on the embankment slopes that have already experienced topsoil sloughing.

10. Have a qualified geotechnical engineer evaluate the dam embankment for stability and seepage with respect to recommended guideline criteria. Assessment of the phreatic surface through the dam may be based on piezometer readings or observed embankment seepage conditions obtained during a sustained high pool period. Place a record of this evaluation on file. Modify the dam as required for stability.

11. Conduct periodic inspections of Marsh Dam at 5-year intervals by engineers experienced in dam design and construction.

12. Monitor future development downstream of Marsh Dam and along Marron Creek relative to damage and hazard potential associated with a dam breach.

REFERENCES

1. U.S. Army Corps of Engineers Office of the Chief of Engineers Report to the U.S. Congress, National Program of Inspection of Dams, Vol. 1, Appendix D, "Recommended Guidelines for Safety Inspection of Dams", Washington, D.C., Department of the Army, May 1975.

2. U.S. Geological Survey, Wolf Point, Montana, AMS, Scale 1:250,000, 1954 with revision 1975.

3. Soil Conservation Service, Project Design Files.

4. Von Hake, C.A., Earthquake Information Bulletin, USGS, Vol. 10, No. 4, 1978.

5. Soil Conservation Service, Engineering Handbook (as published in 1966).

6. Department of Planning and Economic Development, State of Montana, "Comprehensive Area-Wide Water and Sewer Plan, 1970", Volume 5, Daniels, Sheridan, and Roosevelt Counties.

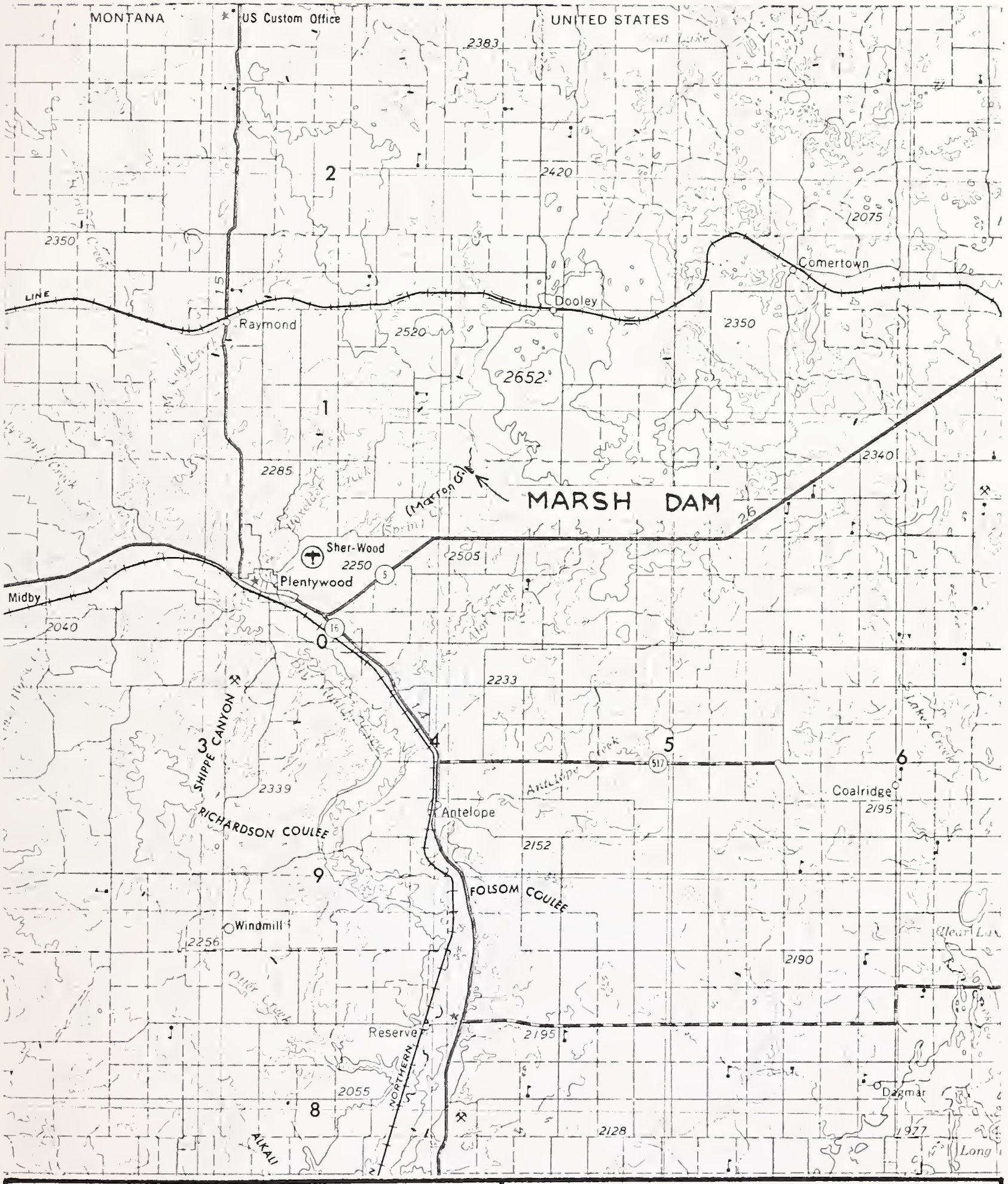
7. U.S. Department of Agriculture (SCS) and U.S. Department of the Interior (Bureau of Indian Affairs) in cooperation with Montana Agricultural Experiment Station, Soil Survey of Sheridan County, Montana, June 1977.

8. National Oceanic and Atmospheric Administration, Climatological Data, Montana, National Climatic Center, Asheville, N.C., 1978.

9. National Oceanic and Atmospheric Administration, Precipitation-Frequency Atlas of the Western United States, Vol. I, Montana, 1973.

APPENDIX A

VICINITY MAP



APPENDIX A
VICINITY MAP
MARSH DAM

APPENDIX B

INSPECTION PHOTOS

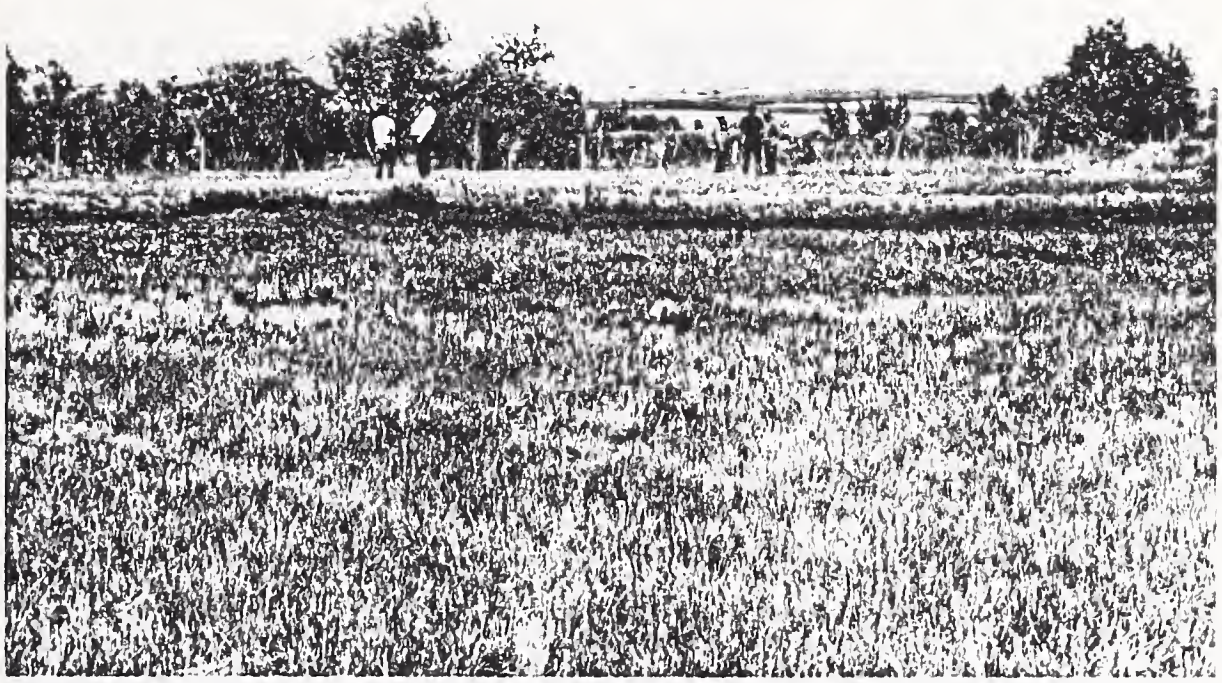


Photo No. 1 - Spillway
Looking up the earthen spillway toward the reservoir. Members of the inspection team are standing in the spillway control section.

Photo No. 2 - Marsh Reservoir and Drainage Area
The upstream drainage area is pictured in the background. Basin consists primarily of rangeland and farmland with gradual slopes and rolling terrain.

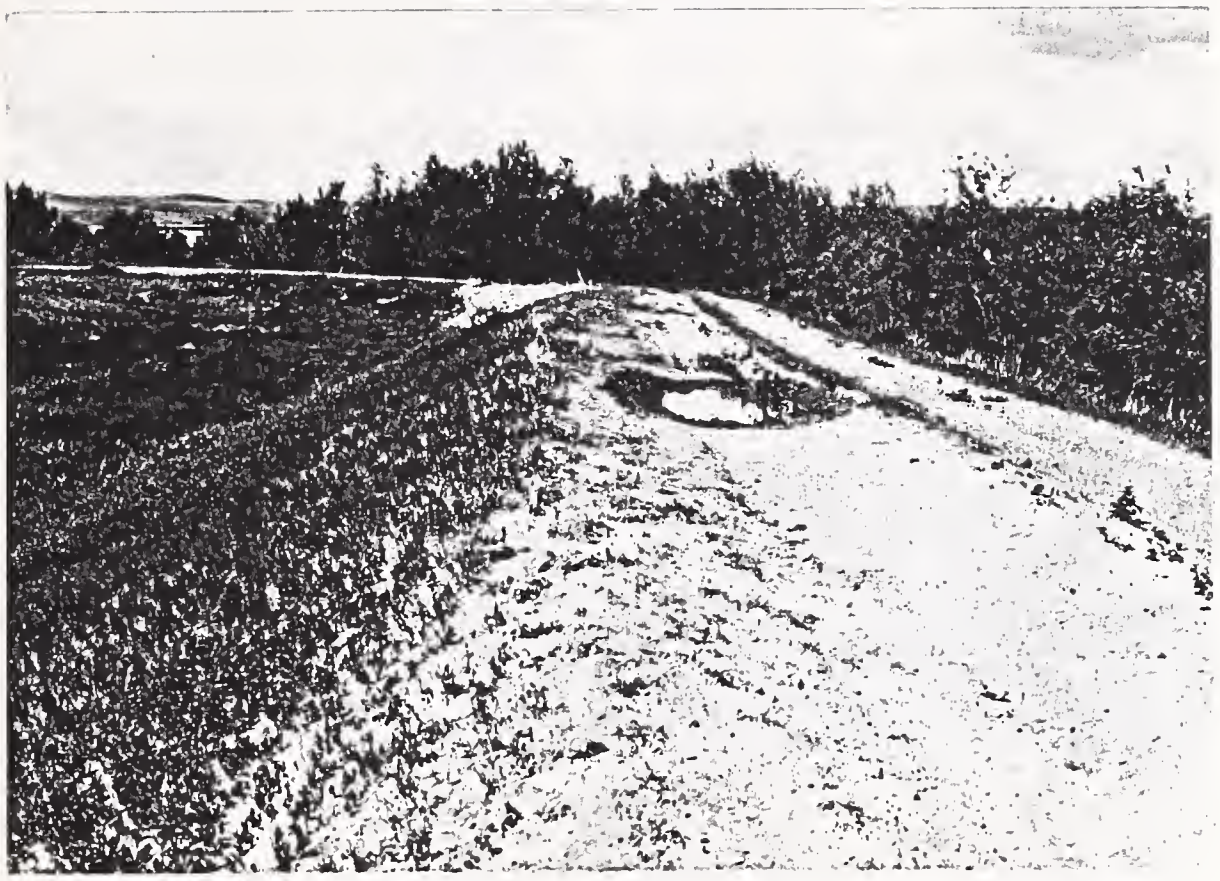


Photo No. 3 - Dam Crest
Looking toward the right abutment. Potholes and ruts have developed due to traffic damage. Note slight slope of the crest toward the upstream side. Vegetative cover on the downstream slope varies from sparse to heavy, increasing downslope to the downstream toe.

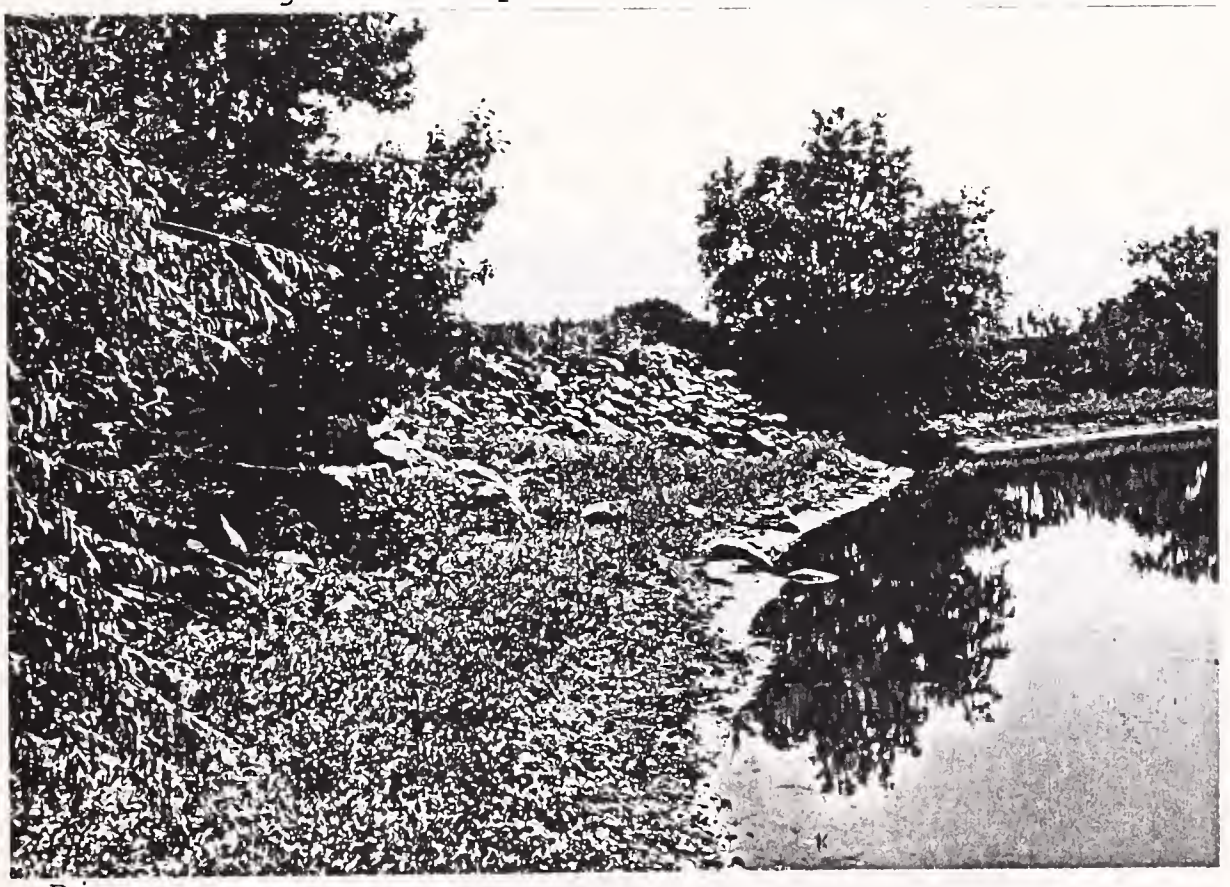


Photo No. 4 - Riprap
Riprap has been placed at isolated locations on the upstream face, but primarily along the southeast shoreline.

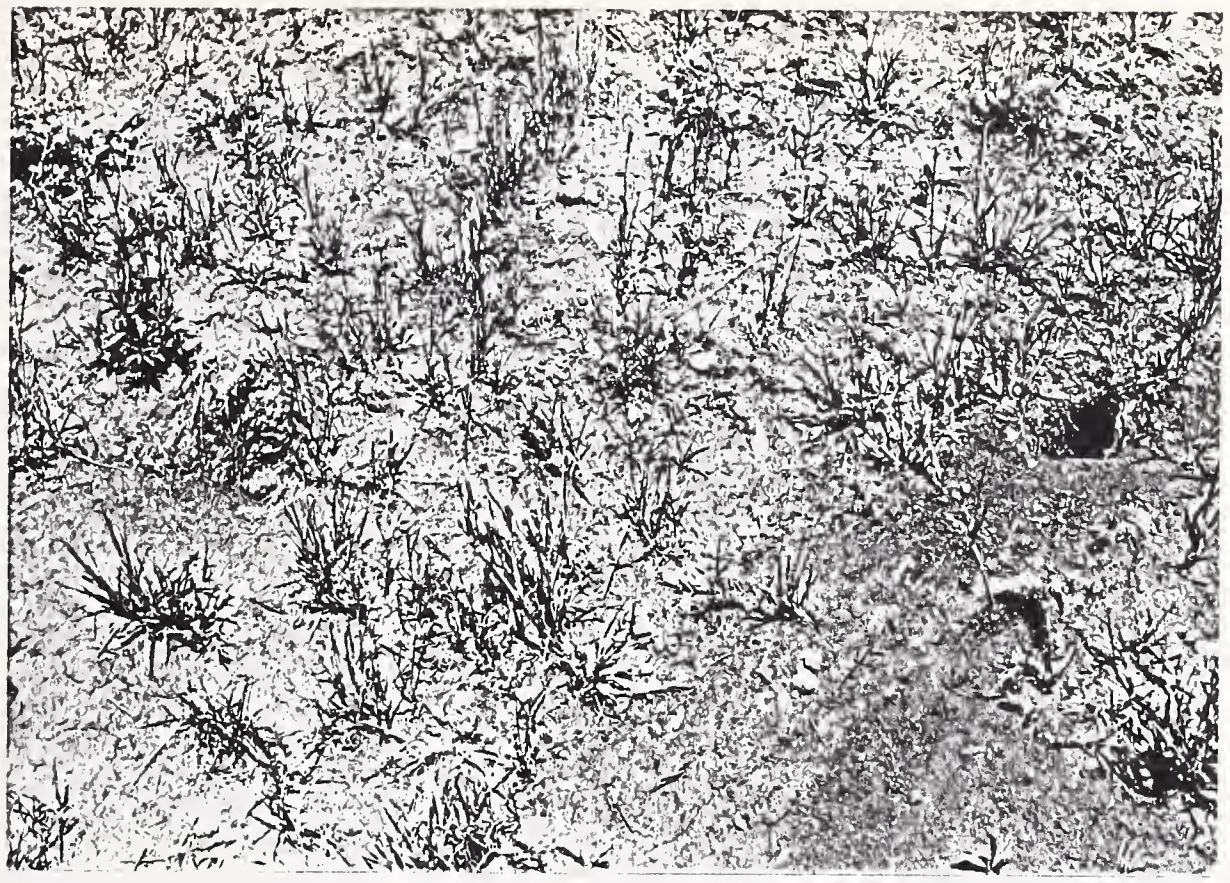


Photo No. 5 - Burrowing Animal Damage
Burrowing animal holes are scattered throughout the downstream face as shown on the far right in this photo.

Photo No. 6 - Downstream Area
The downstream valley is shallow with widths of from 200 to 600 feet, for a distance of about 6 miles. Then it broadens to more than 1000 feet in width. Note also the presence of lush vegetation immediately downstream, which is a result of seepage water.

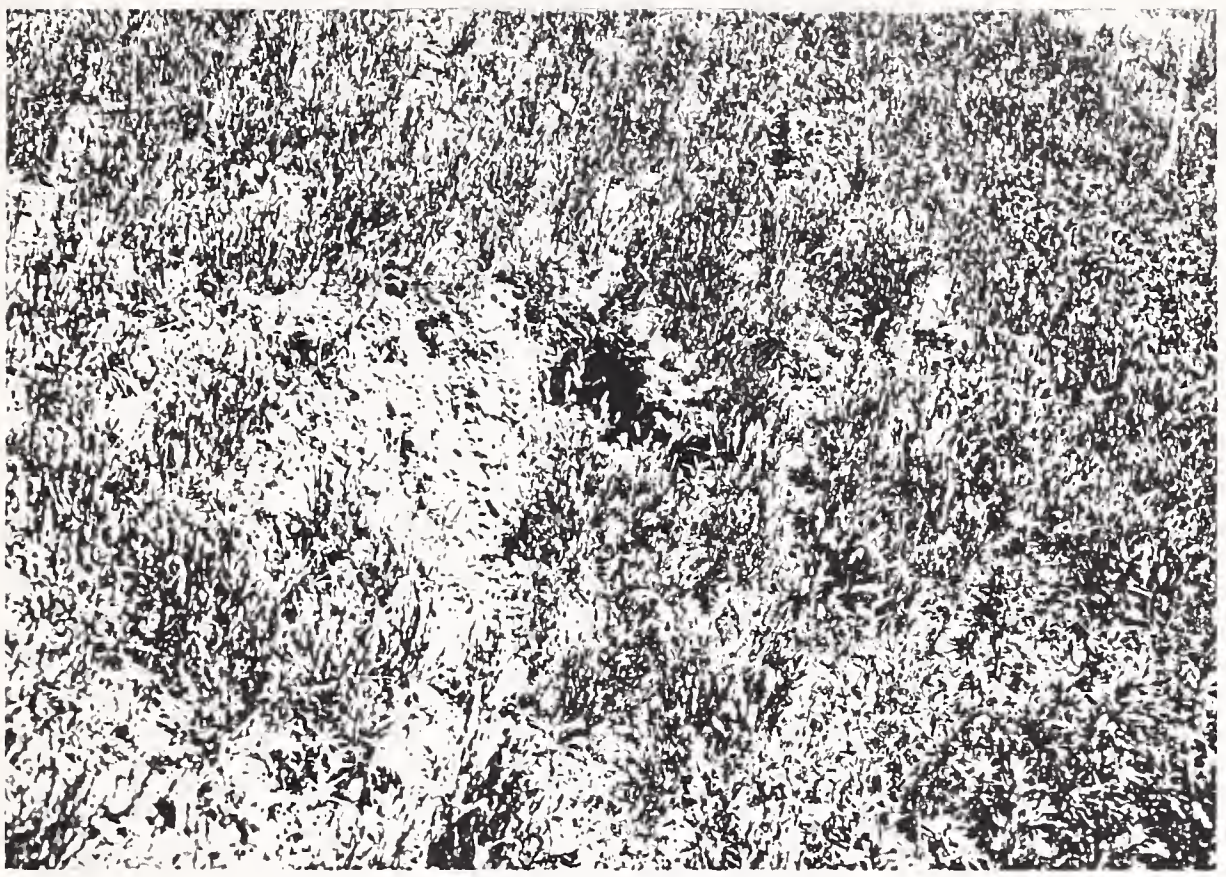


Photo No. 7 - An Escarpment
A small scarp about 6 inches high. Several undulations on the downstream face were observed on the embankment. They are the result of top-soil slippage.

APPENDIX C

PROJECT DRAWINGS

EXHIBIT C1	PLAN VIEW AND EMBANKMENT SLOPES
EXHIBIT C2	DAM CREST PROFILE
EXHIBIT C3	EMBANKMENT SECTIONS
EXHIBIT C4	SPILLWAY DETAILS

NOTE:
INFORMATION SHOWN
DERIVED FROM FIELD
SURVEY 7/10/80

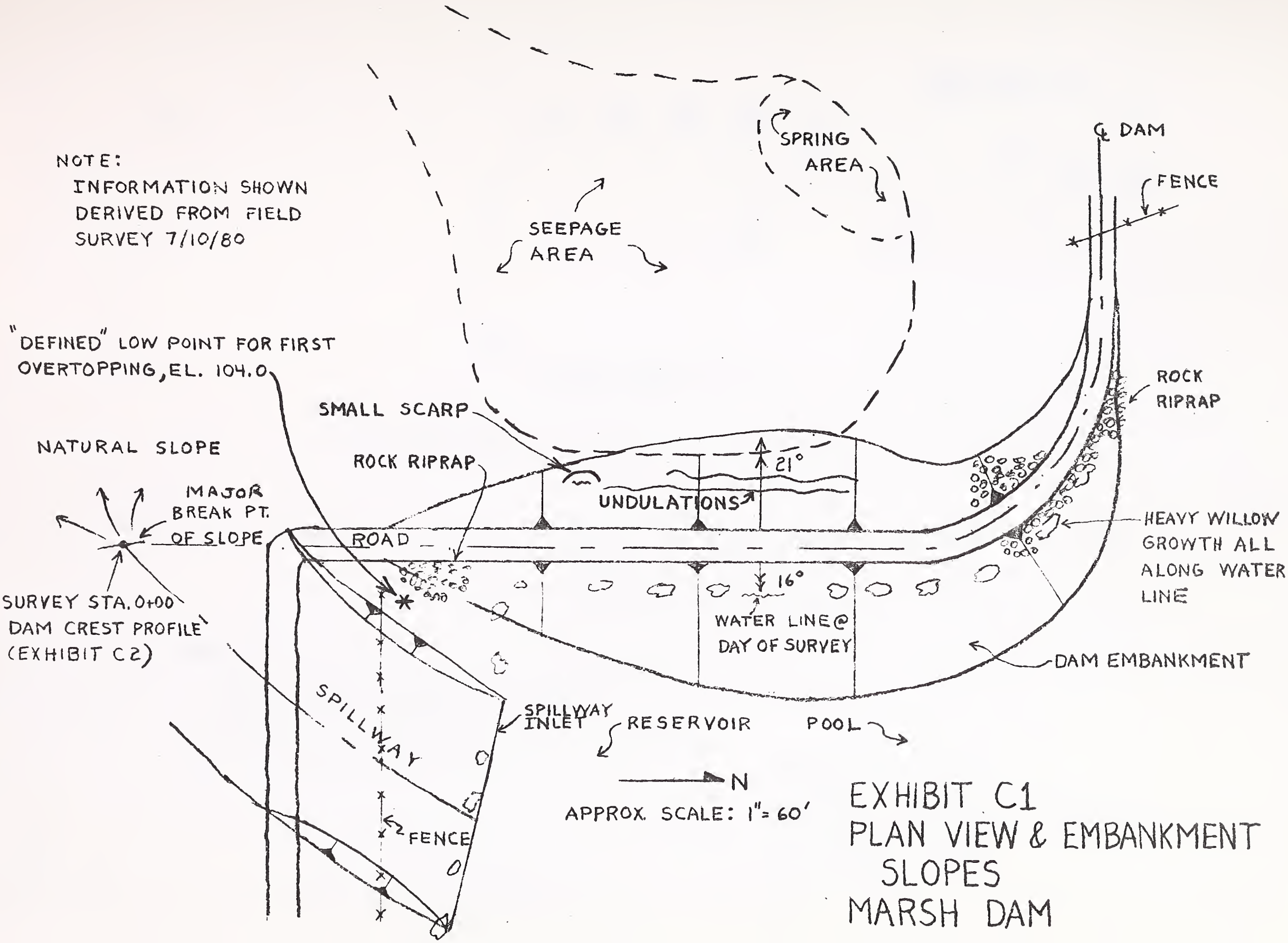
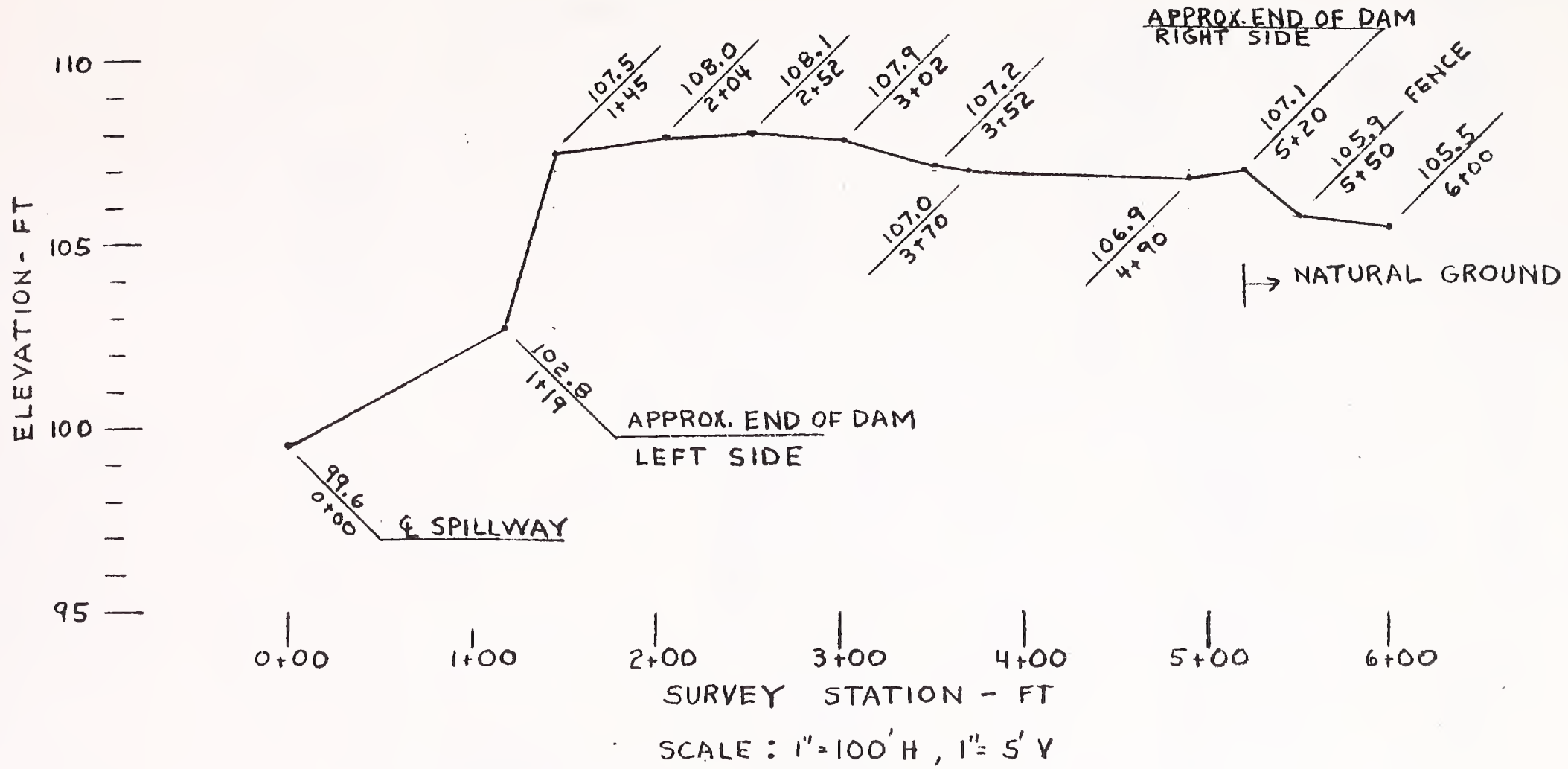


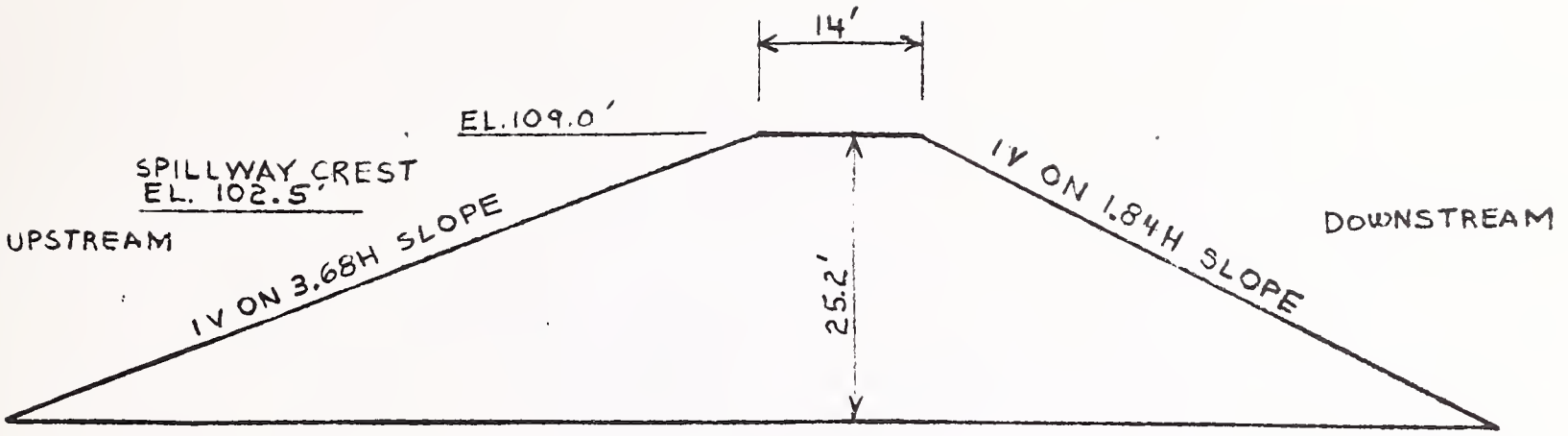
EXHIBIT C1
PLAN VIEW & EMBANKMENT SLOPES
MARSH DAM



NOTES:

1. ALL STATIONS & ELEVATIONS TAKEN FROM FIELD SURVEY 7/10/80
2. BASE EL. USED WAS CREST OF SPILLWAY = EL. 102.5 (SEE EXHIBITS C1 & C4)

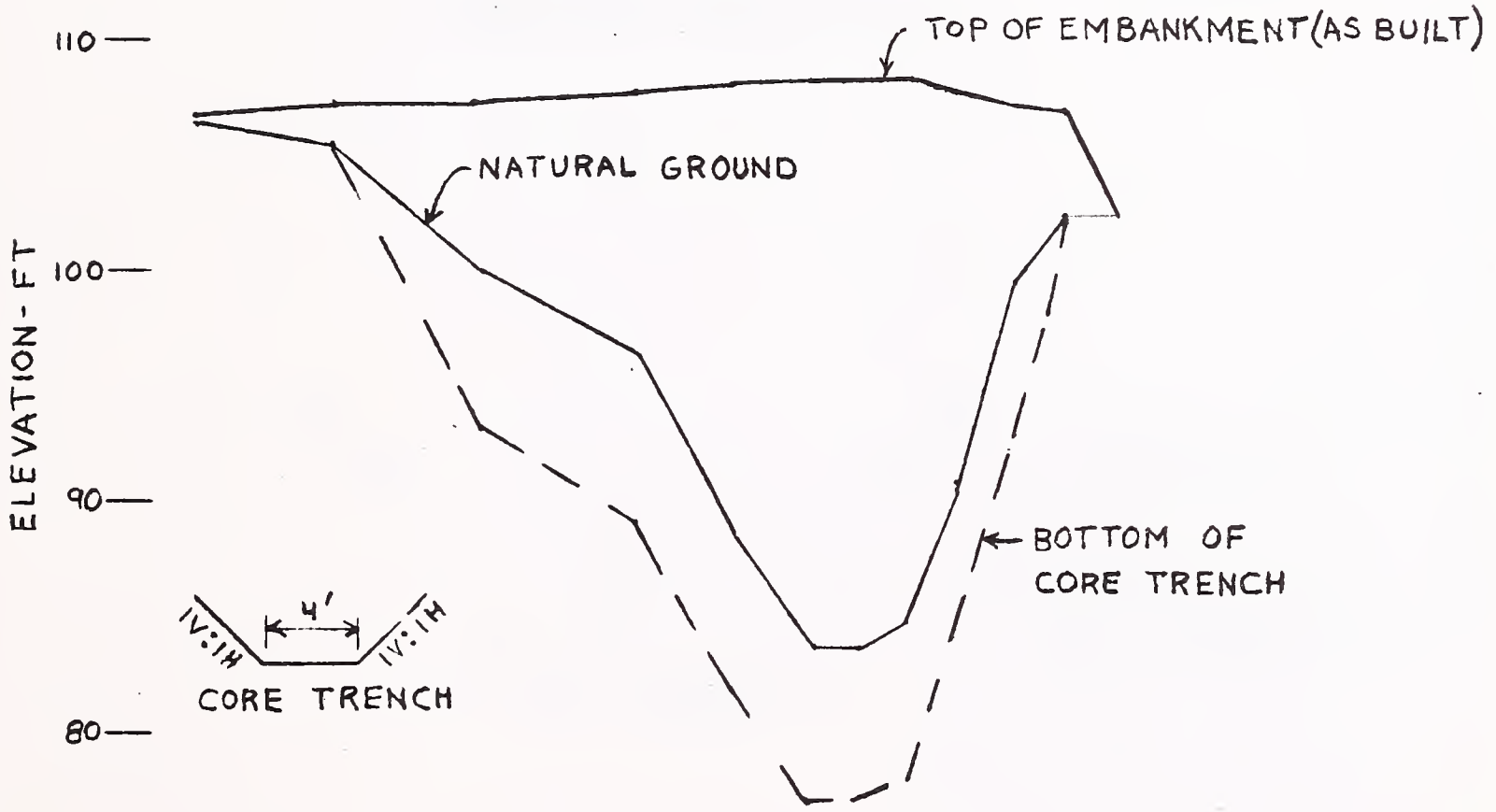
EXHIBIT C2
DAM CREST PROFILE
MARSH DAM



No Scale

"AS BUILT" SECTION @ STA. 2+27

SOURCE:
SCS DESIGN FILES

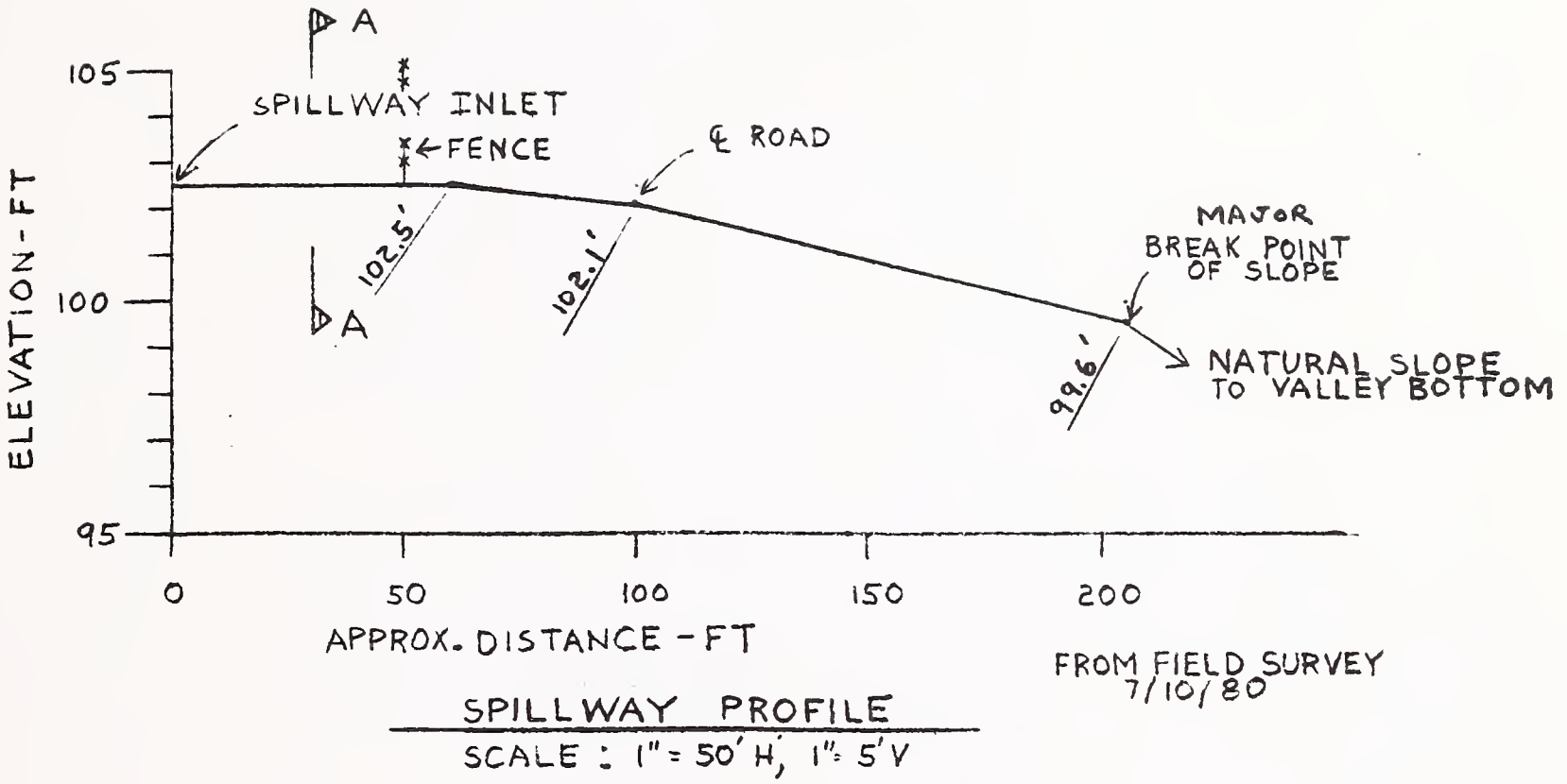


Scale: 1"=100'H, 1"=10'V

FINAL EMBANKMENT SECTION ALONG DAM ℄

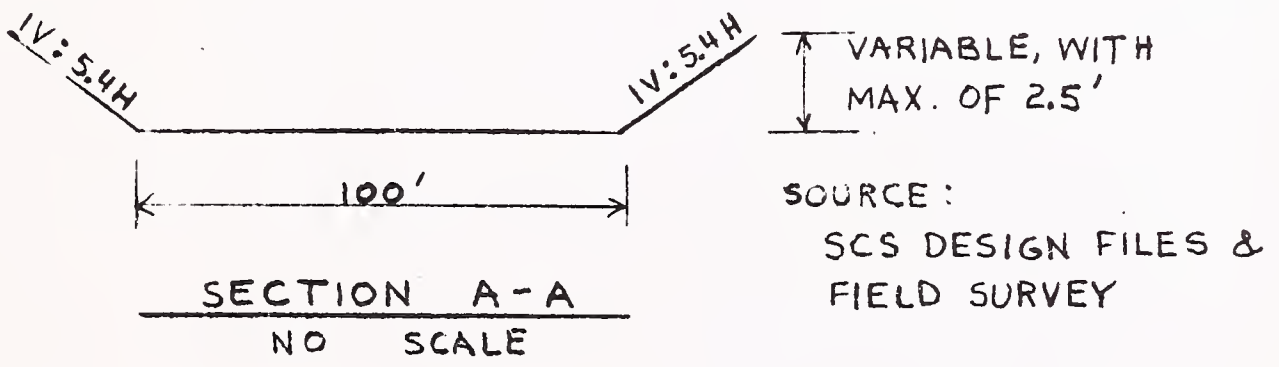
SOURCE:
SCS DESIGN FILES

EXHIBIT C3
EMBANKMENT SECTIONS
MARSH DAM



SPILLWAY PROFILE

SCALE : 1" = 50' H, 1" = 5' V



SECTION A-A

NO SCALE

SOURCE :
SCS DESIGN FILES &
FIELD SURVEY

EXHIBIT C4
SPILLWAY DETAILS
MARSH DAM

APPENDIX D

HYDROLOGY/HYDRAULICS BACKUP

APPENDIX D

HKM ASSOCIATES COMPUTATION SHEET

By	Date	Project No.	Sheet
MDK	9/23/80	7M140.113	1 of 4
Chkd by	**Date**	**Name**	
		MARSH DAM – MT 1543	
Details		**Feature**	
100-yr, 6-hr Storm		Runoff Hydrograph - SCS Method	

Information as supplied by the SCS in the 1966 design files:

DA = 1010 acres = 1.6 sq mi
Time of Concentration = 0.78 ≈ 0.80 hrs
Weighted Soil Cover Complex No. (CN) = 75

Consider a 100-yr, 6-hr rainstorm on the contributory watershed:

P = 3.3" (NOAA Atlas II, Vol. I, Montana, 1973)
Adjust CN to 80 to account for storm severity (the SCS used CN = 75 previously for a 25-yr, 6-hr event)

Refer to Sheets 2 and 3 for the runoff hydrograph results.

DESIGN HYDROGRAPH COMPUTATION

S.C.S. METHOD

STUDIED BY H.K.M. ASSOCIATES

MARRON CREEK

DRAINAGE AREA = 1.60 SQ.MI.

RUNOFF CONDITION NO. II

RUNOFF CURVE NO. 80

TIME OF CONCENTRATION = 0.80 HR.

STORM DURATION = 6.00 HR.

POINT RAINFALL = 3.30 IN. (FOR SIX HOURS DURATION)

ADJUSTED RAINFALL

AREAL ** FACTOR 1.000 RAINFALL 3.30 IN.

RUNOFF AMOUNT = 1.48 IN. = 125 AF

HYDROGRAPH FAMILY NO. III

COMPUTED T_P = 0.56 HR. T_O = 4.37 HR.

(T_O / T_P) COMPUTED = 7.81 USED = 6.00

REVISED T_P = 0.730 HR.

$$Q_P = \frac{484 * A}{REV.\ T_P} = 1060.82 \text{ CFS.}$$

QQ_P = 1570.0100 CFS.

DESIGN HYDROGRAPH COMPUTATION

S.C.S. METHOD

STUDIED BY H.K.M. ASSOCIATES

MARRON CREEK

		HOURS	CFS		
		0.000	0		
		0.250	2		
		0.500	21		
		0.750	114		
		1.000	291		
		1.250	510		
		1.500	600		
PEAK	*****	1.533	612	*****	PEAK
		1.750	582		
		2.000	529		
		2.250	469		
		2.500	414		
		2.750	366		
		3.000	323		
		3.250	288		
		3.500	260		
		3.750	239		
		4.000	225		
		4.250	216		
		4.500	204		
		4.750	179		
		5.000	140		
		5.250	93		
		5.500	54		
		5.750	34		
		6.000	21		
		6.250	12		
		6.500	7		
		6.750	4		
		7.000	3		
		7.250	2		
		7.500	1		
		7.750	0		
		7.971	0		

HKM ASSOCIATES COMPUTATION SHEET

By	Date	Project No.	Sheet 4 of 4
MDK	9/23/80	7M140.113	
Chkd by	**Date**	**Name**	
		MARSH DAM - MT 1543	
Details		**Feature**	
Hydraulic Capacity		Spillway	

Spillway Type: Uncontrolled
Broad-crested (level control section ≈ 60'-70')
Earthen with grass and weed cover, and occasionally some willow obstruction at the entrance when not maintained

Spillway Shape: Trapezoidal for approx. 100 feet d/s of inlet, then transitions to natural terrain and sheet flow

Spillway Dimensions: Base Width (L) = 100'
Side Slopes ≈ 1V on 5H
Bank Heights: max of 2.5' at deepest cut approx 30' to 40' d/s of inlet.
Control Elev = 102.5 feet, local datum

Use broad-crested weir theory ($Q = CLH^{3/2}$).

Assume "C" = 2.4 for dense vegetative cover and occasionally willows or willow stubble. Entrance losses to the spillway channel are considered insignificant. Because we are dealing with a small range of head (H) values before first overtopping of dam embankment, assume "C" remains constant throughout the study range. Also, assume L=100' is effective length for all "H's".

H, ft	Q, cfs
0.5	85
1.0	240
1.5	440
2.0	680

First overtopping of the dam embankment appears to occur between the cut spillway channel and the left side of the embankment (Exhibits C1 and C2) at about elev. 104.0 feet. This is equivalent to an "H" value of about 1.5'. Thus, existing spillway capacity prior to an overtopping condition is about 440 cfs.

APPENDIX E

CORRESPONDENCE

Gordon Thompson
Plentywood Mont 59254
Dec. 10, 1980

To whom it may concern,

In view of your evaluation of the potential danger of the Marsh dam. I feel if we keep the spillway clear, which we plan to do this winter, also continue riprapping to prevent wave action, keep close attention to any abnormalities. Also in the event of a so-called one hundred year six hour rain, there would be ample time to warn the people in the one dwelling on Marron creek.
I feel in view of these suggestions this dam is comparatively safe.

Respectfully
Gordon Thompson

"Comment on "Mark Damm""
Dave Mark And Gordon Thompson Co owners
12 Dec. 1980

To whom it may Concern.

I feel that we "Co owners" of "Mark Damm" are going to do everything in our power to keep it "Safe and available" for interested people for fishing Purposes which is its main Purpose. The damm is inspected Regular by the owners and other Interested personell for any faults which may occur.

We are going to do some tree and willow cleaning from the spillway soon, we also will continue Rip rapping the banks where its needed most and will continue from there also.

We have also been inspecting the spillway itself and Repairing washing Etc. as it Develops. also am going to take care of the Ruts on damm Surface as they as there is a trail on damm.

I feel that the damm is fairly well Packed after all these years and only a 100 yr flood, could even think of damaging the Surface. I feel this damm could have a small amount of spillway work done if so desired, but don't think it really needs it right now.

I agree with Mister Gordon Thompson that the damm is in a Safe Position as of now, we Believe with some Effort we can keep it that way.

If any thing arises on this or any information is needed feel free to call. Present Phone No. 1-406-895-2639

David J Mark
Ridgewood Mont.
RT 2 Box 10 59254

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE, GOVERNOR

32 SOUTH EWING

STATE OF MONTANA

(406) 449-2872

HELENA, MONTANA 59601

November 13, 1980

Ralph Morrison
Department of the Army
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, Washington 98124

Dear Mr. Morrison:

The Department of Natural Resources and Conservation has reviewed the draft of the Memo-for-Record on Marsh Dam (MT-1543). We concur with the findings and recommendations and feel that the report satisfies the criteria for the Phase I evaluation.

Thank you for this opportunity to review and comment on the final draft report for this project.

Sincerely,

Richard L. Bondy, P.E.
Chier, Engineering Bureau
(406) 449-2864

RB/LT:lj

"AN EQUAL OPPORTUNITY EMPLOYER"

United States Department of Agriculture
Soil Conservation Service
P.O. Box 970
Bozeman, MT
59715

January 8, 1981

Sidney Knutson, P.E.
Assistant Chief
Engineering Division
Seattle District, Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124

Dear Mr. Knutson:

Thank you for the opportunity to review the final draft report on Marsh Dam (MT-1543).

Our revised comments relating to specific report statements are:

Page 3, line 12: Gus Abenroth's proper title is Soil Conservation Technician. His design of the dam would have been approved by the Area Engineer.

Page 7, line 4: There were no specific construction specifications developed for a project of this size, however, the appropriate Montana Standard Construction Specifications were applicable.

Page 9, line 17: Complete spillway discharge rating data was not developed during design because of the scope of the project. It is all relative; see page 10, line 8.

Page 16, line 1: Change "Area" to "Field".

Throughout Report: Change "Morrow" Creek to "Marrow" Creek

Page 20, line 4: There are 8 channel miles between the dam and the first dwelling. The total drainage area above the first dwelling is 7,800 acres. The 1,000 acre drainage above the dam is only 15% of the total drainage. We feel the 60 acre feet of stored water would not be a significant addition to the peak flow from the total 7,800 acre watershed during the 100-year- 6-hour storm. We feel the hazard class is not realistic.

Appendix D: The SCS field technician estimated a curve number (CN) of 75 during design. The consultants increasing the CN to 80 increases the yield by approximately 20%. As the CN is a measure of ground cover influence, we cannot conceive how it can be affected by the storm severity. This contention should be supported or yields recalculated.

Page 20: Should the term be "public" utilities rather than "private"? Telephone lines are buried, only power poles are exposed to damage. The only private roads are field access trails that are not affected by flooding. There is one well traveled county road, one mile downstream of the dam. A second county road 2-2½ miles downstream is in poor condition and is less traveled. We felt the hazard class is not realistic.

We request that the meteorologic and hydrologic conditions used to develop the flood magnitude be given and justified. We urge that a breach flood routing be made to determine the actual downstream hazard classification.

Sincerely,

Van K Haderlie

Van K Haderlie
State Conservationist

cc:
Ray Smith, Acting State Conservation Engineer, SCS, Bozeman
Dave Jones, Environmental Engineer, SCS, Bozeman